FEDERAL AVIATION ADMINISTRATION

THE EFFECT OF AIRPORT NOISE ON HOUSING VALUES: A SUMMARY REPORT

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16. Abstract

This report describes the results of a "bottom up" examination of the impact of airport noise on housing values. The primary objective of this assessment was to determine whether a valid national level determination regarding the impact of airport noise on housing values could be made based on studies at individual airports. The studies were not intended to obtain precise values of the noise impact on property values around the airports that were considered.

An analytical approach was designed that combined quantitative and qualitative techniques in a way that complements each and overcomes some of the shortcomings of previous studies that exclusively used one technique or the other. In recognition of the fact that local conditions can significantly affect real estate markets, this approach makes extensive use of local realtors and appraisers who are familiar with the area and any unique factors that must be considered when assessing the value of residential properties.

This approach was used around airports in three major metropolitan areas to determine if the approach was repeatable and verifiable, and whether it provided consistent and reliable results in terms of trends regarding the economic impact of airport noise on housing values. They were also intended to assess the reliability and accessibility of the data required for such analyses. It was concluded that this approach represents a viable method of examining the effects of airport noise on housing values at the national level. A correct application of sampling methods and the analytical technique can be used to establish the nationwide magnitude of the effect that airport noise has on property values, and may help decision makers determine national policy or guidelines regarding the impact of airport noise on housing values.

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EXECUTIVE SUMMARY

The impact of airport noise on housing values has been the subject of numerous studies in the past. Although these studies have been useful in providing some insight into this complex issue, it is difficult to draw any clear and unambiguous conclusions from the results, since each of the studies used a variety of quantitative and qualitative techniques, different measures of noise, and dissimilar sources of information. Therefore, the results of these past studies are subject to interpretation and cannot be applied to airports in any general overall sense.

The Federal Aviation Administration's (FAA's) Office of Environment and Energy (AEE) performed a "bottom-up" examination of the nationwide impact of airport noise on housing values. The primary objective of this assessment was to determine whether a valid national level determination regarding the impact of airport noise on housing values could be made based on studies at individual airports. The studies were not intended to obtain precise values of the noise impact on property values around the airports that were considered.

An analytical approach was designed that combines quantitative and qualitative techniques in a way that complements each and overcomes some of the shortcomings of previous studies that exclusively used one technique or the other. In recognition of the fact that local conditions can significantly affect real estate markets, this approach makes extensive use of local realtors and appraisers who are familiar with the area and may be aware of unique factors that must be considered when assessing the value of residential properties.

The underlying assumption of this approach (referred to as the "neighborhood pair model") is that housing values are determined by a combination of neighborhood characteristics (e.g., the quality of local schools, local property taxes, and the crime rate) and individual housing characteristics (e.g., age of the house, number of rooms, and amenities such as swimming pools and garages). Two neighborhoods—one exposed to higher noise levels than the other—with similar characteristics are chosen. If the property values are "normalized" so that the housing traits are also comparable and airport noise is the only apparent difference, then any difference in the property value could be attributed to airport noise.

Studies were performed around airports in three major metropolitan areas. Each of the airports had well-documented noise impact information, were moderately affected by the economic changes of the past 4 years (relative to other parts of the country), and are located in communities that are not extremely sensitive to noise. These studies were intended to examine whether the analytical approach used was repeatable and verifiable and whether it

provided consistent and reliable results in terms of trends observed regarding the impact of airport noise on property values. They were also intended to assess the reliability and accessibility of the data required for such analyses.

A pilot study was conducted at Baltimore-Washington International Airport (BWI) to determine the effectiveness of the analytical procedure. Implementation of the approach proved to be feasible and economical, but the study was constrained by the limited number of residential neighborhoods that could be considered, as well as the narrow range of property values. A second study was conducted around Los Angeles International Airport (LAX) where there are a larger number of neighborhoods to choose from with a considerably wider range of property values. A third study examined areas around New York's La Guardia (LGA) and John F. Kennedy International (JFK) Airports and was designed to see if the trends detected around Los Angeles could be observed in a similarly diversified metropolitan environment.

The results of these studies indicate that the neighborhood pair model is viable and reasonably economical to implement. It serves as a tool to establish the lower and upper bounds of the effect that airport noise has on housing values. The trends observed are consistent, with the impact apparently more pronounced in higher-priced areas than in relatively low-priced neighborhoods.

However, no generalization can be made regarding the quantification of this impact on a nationwide basis, since there was such a wide variation in the extent of impact—from negligible to significant—and only a limited number of neighborhood pairs around a small sample of airports from the national airspace system was considered. In general, these studies establish a framework upon which a broader examination of this subject at the national level can be based. Such a study would seek to determine the magnitude of the impact of airport noise on housing values on a nationwide basis rather than focusing on specific airports.

Prior to performing a nationwide study, two closely linked issues must be resolved: which airport-impacted communities must be considered, and how many such communities must be analyzed. Clearly such a study must consider only communities that are representative of those that are affected by airport operations nationwide. However, U.S. airports and the communities they impact vary considerably in terms of size, areas impacted, and other characteristics. Hence, it is possible to categorize them on the basis of several discriminating factors, including airport size, economic status of the communities, and the importance of the airport as a local employer, with each classification testing a different hypothesis (e.g., grouping airports in terms of their role as local employers would determine whether home buyers are willing to pay for the privilege of decreased commuting distance, and, in so doing, are

willing to be exposed to relatively higher noise levels). The neighborhood pair model would then be implemented at a representative sample of airports from each category.

Two possible methods may be used to determine the number of airports where the analyses are performed. One way of approaching this nationwide study is to implement the neighborhood pair model at airports in each category where sufficient data are available until the average noise impact measured reaches a relatively stable value. This approach, while feasible, could prove quite expensive in practice. A more cost-effective examination of this issue would use modern statistical techniques to determine the correct sample size, which would depend on the total population being considered as well as the level of error that can be tolerated.

If the sample sizes are correctly chosen, and the studies are conducted using the appropriate number of neighborhood pairs and noise levels, it is likely that anomalies due to local conditions as well as other confounding effects (e.g., changes in property value due to interest rate changes) will average out, and ultimately the resulting magnitude of airport noise impact will "regress toward the mean."

In conclusion, a viable technique exists to examine the effects of airport noise on housing levels at the national level. A correct application of sampling methods and the analytical technique can be used to establish the nationwide magnitude of the effect that airport noise has on property values and can help decision makers determine national policy or guidelines regarding the impact of airport noise on housing values.

1. INTRODUCTION

The issue of airport noise and its effect on nearby communities has been studied extensively by the Federal Aviation Administration (FAA). The FAA and public interest groups as well as the U.S. Congress have examined different aspects of this issue for the past two decades and have worked hard for legislation and policies to minimize, to the extent possible, the impact of aircraft noise on people.

The ongoing research efforts of the FAA and other Government agencies have resulted in considerable progress in the area of aircraft noise mitigation: the Part 36 noise certification standards issued in 1969 were a landmark, and the passage of the Aviation and Noise Capacity Act (ANCA) of 1990, mandates, among other things, the gradual conversion (by the year 2000) of all the nation's aircraft to quieter, more efficient Stage 3 aircraft. This process is currently underway and will result in a significant decrease in the overall impact of aircraft operations on communities around airports.

To implement any proposed (change in) noise-related policies or regulations, the costs and benefits must be evaluated in detail to determine whether the policy has a net benefit to the nation and, if so, whether it is economically feasible. One aspect of noise that remains the subject of considerable debate and controversy is its economic impact, which is generally quantified in terms of its effect on housing values. The costs and benefits of airport noise and noise reduction measures have been examined by numerous researchers in the past two decades. This body of work is discussed briefly below.

These studies were reviewed in detail to determine what techniques and measures were used to understand this issue, what conclusions were drawn from the investigations, and whether there is any broad agreement regarding these conclusions and results. In general, previous studies that examined the economic impact of airport noise can be categorized as follows:

- *Cost-effectiveness analyses* (Ref: 1, 2, 7, 8, 17)—Attempted to comparatively value the cost-effectiveness of noise reduction measures

- *Property value analyses* (Ref: 3-7, 9-16)—Used either econometric techniques or qualitative methods to determine the incremental value of quiet to homeowners as reflected in the incremental price they are willing to pay for quiet

- *Modeling studies* (Ref: 18, 19)—Used computer models to estimate nationwide costs and benefits of noise mitigation measures.

The studies were performed at various North American airports to evaluate alternative methods for assessing the costs and benefits of airport noise mitigation. In most cases, the studies sought to determine the relationship between airport noise and the value of real estate around airports. While these studies shed some light on this complex issue, it is difficult to use them collectively to arrive at definitive conclusions.

There were some inconsistencies, even within each study, in the units used to quantify benefits and costs. Several different proxies were used to represent property values, and these proxies varied in terms of the level of detailed information captured; e.g., some studies considered actual sales data (Ref: 11), others considered average census tract property values (Ref: 4), and others used the average census block data (Ref: 9). There was also considerable variation in the noise descriptors used—ranging from the standard Day-Night Average Sound Level, or DNL (Ref: 1,2), to Noise Exposure Forecast, or NEF (Ref: 10,12), to subjective measures such as "moderate" and "substantial" (Ref: 14,15). Each study typically focused primarily on individual airports; the few that considered several airports (Ref: 4,7) yielded disappointing results by virtue of the use of highly aggregated census tract-level data, which do not include key variables such as living area or lot size.

All these factors make it difficult to arrive at any clear and unambiguous conclusions regarding airport noise and its impact on housing value, and a need was perceived to develop a standard and credible method to quantify this effect.

This report describes a series of studies that were conducted at airports in three major metropolitan areas—Baltimore, Los Angeles, and New York. The primary intent of these studies was to determine the effectiveness of an analytical procedure that was designed to estimate the effects of airport noise on housing values and to evaluate the applicability of the study results at the national level.

Chapter 2 contains a detailed description of the analytical procedure. Chapter 3 describes how this procedure was implemented around four major domestic airports, as well as the results of these studies. Chapter 4 gives some suggestions regarding how the analytical approach could be implemented at the national level. Chapter 5 presents overall comments about the studies and the conclusions drawn from them. Chapter 6 provides a bibliography of the literature that was reviewed.

2. ANALYTICAL APPROACH

The FAA must perform extensive cost-benefit analyses before implementing proposed changes in national noise-related policies. One aspect of aviation noise that needs to be understood better is its economic impact. To do so, a feasible and reasonably economical method of quantifying this effect was required. After a detailed examination of previous studies that examined this issue, a method that seeks to avoid most of the shortcomings of these past studies was devised, as described below.

The analytical approach that was designed was based on the following premises:

- The value of a home is best represented to its owners by market values. In general, home buyers are willing to pay more for houses with favorable characteristics, which may be classified under the following two sets of attributes:

  — Neighborhood characteristics, such as the quality of schools, crime rate, and property taxes

  — Individual house characteristics, such as its size, architectural style, age, and amenities such as a garage, outdoor patio, or pool.

- For any two houses, if these two sets of characteristics are normalized until airport noise is the only apparent difference, then any difference in the value of the two houses can be attributed to airport noise.

Certain conditions that are unique to a given part of the country can play an important role in determining the property values in that area. A downturn in the local economy, for example, can result in a significant decrease in the sale of homes even though the real estate market in the rest of the nation is functioning relatively well. In recognition of this fact, this approach takes advantage of the expertise of local realtors and appraisers, who understand local conditions and can take these into account when selecting properties for analysis. Furthermore, these individuals will use their judgment and experience to consider factors that are difficult or often impossible to quantify satisfactorily.

Hence, the approach is a combination of both quantitative and qualitative factors. A three-step procedure to determine the effect of airport noise on housing values was devised incorporating these assumptions. These steps are:

- Step 1. Identify two neighborhoods that have similar characteristics except for noise levels.

- Step 2. Select sample houses from each neighborhood to normalize individual housing characteristics.

- Step 3. Compare housing values in the two neighborhoods based on real estate appraisal applications and regression modeling.

Each step is described below.

2.1 Step 1. Identification of Neighborhoods

During this phase of the process, a pool of local realtors from a number of leading real estate agencies in the city is surveyed to assess the primary neighborhood characteristics that influence home buyers in the vicinity of the airport in question. They are asked to rate these characteristics in decreasing level of importance. The neighborhood traits considered (as recommended by the National Board of Realtors) are:

- Property taxes
- Crime rate
- Quality of neighboring residential units
- Racial/ethnic/social characteristics
- Local traffic conditions/congestion
- Nearness to commercial and shopping centers
- Quality of local schools
- Quality of municipal services
- Access to public transportation
- Commuting distance
- Quality and proximity of recreational facilities.

The results of these surveys are then analyzed and tabulated for all the realtors collectively as well as for the subsample of those realtors serving the airport. These results are examined to determine which realtor's judgment most closely approximates the average survey statistics. This realtor is identified as the "norm" realtor.

As a person with a great degree of familiarity with local conditions, the norm realtor is instrumental in gaining an in-depth understanding of the real state market around the airport in question. A site survey of the residential neighborhoods impacted by airport operations is performed, and the social, ethnic, and economic conditions in the airport vicinity are evaluated. Based on the results of these surveys, the airport environs are subdivided into those that have similar neighborhood characteristics.

Finally, the results of these surveys are used to choose two similar neighborhoods that are exposed to two distinct noise levels—one high and one low (referred to in the remainder of this report as a "neighborhood pair"). If possible, more than one neighborhood pair is selected to represent different ranges of property values. For example, one pair may be chosen to represent relatively low-priced homes, while another pair could be characteristic of more high-priced homes (depending on the airport chosen for analysis, this may or may not be possible).

Noise exposure is quantified in terms of the DNL level that neighborhoods experience. Most airports maintain up-to-date DNL noise contours that are available to the public. This is the standard measure of noise used by airports since it captures information regarding individual aircraft noise levels, the number of operations associated with each aircraft, and the increased sensitivity of people to nighttime operations.

The end result of this step of the analytical process is the identification of neighborhood pairs with similar characteristics except for noise levels (see Figure 2-1). A set of homes is then chosen from each of these neighborhoods for further analysis, as described below.

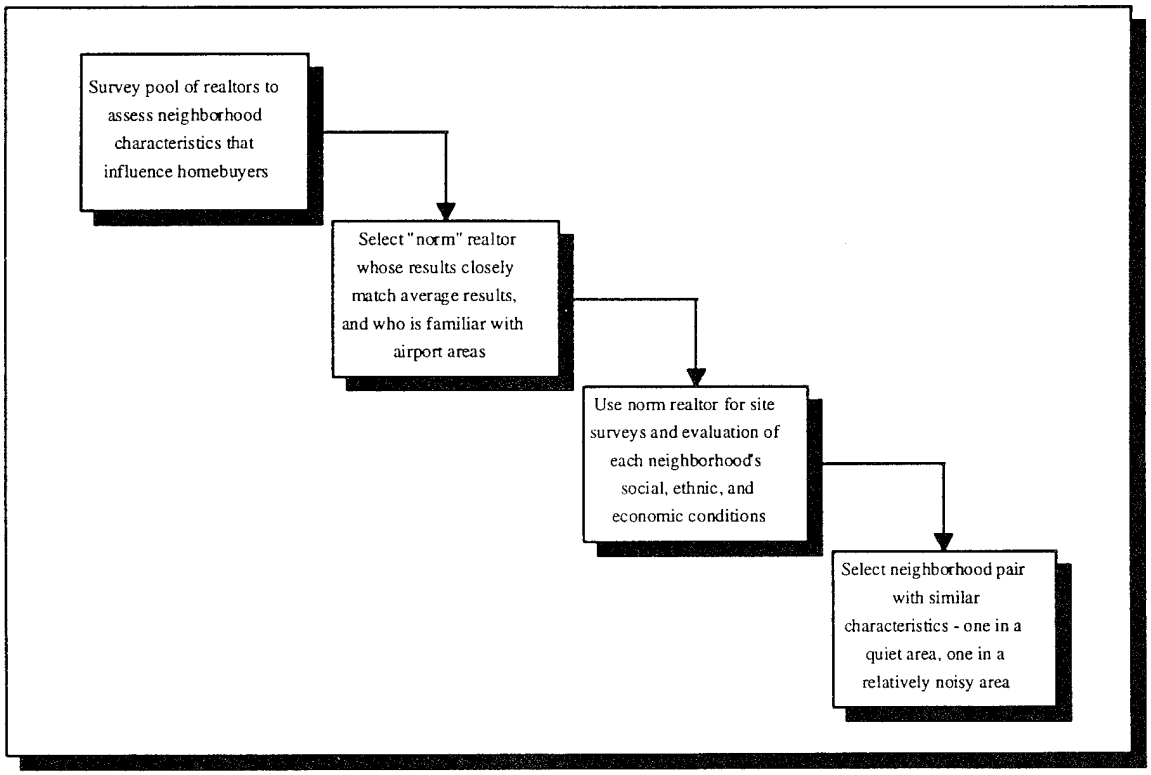

FIGURE 2-1. Selection of a Neighborhood Pair around an Airport

2.2 Step 2. Selection of Sample Houses from Each Neighborhood

In the second step, a sample of recently sold homes is selected from each of the neighborhoods identified. A number of data sources may be used to get the most accurate and complete information possible about each home. Typically, these sources include:

- Multiple Listing Service (MLS)
- Redi Data
- Comps, Inc.
- Local building department records
- Tax assessment reports.

The homes are selected based on the following criteria:

- They have been sold recently (typically, within the past 12 months).
- They have similar housing characteristics and amenities such as:
  - — Age, number of rooms and bathrooms, and square footage
  - — Items such as a swimming pool, garage, and/or spa.

The recorded sale price is obtained for each of these homes. Thus, the end result of this step of the analytical process is the identification of a set of homes in each neighborhood selected with roughly similar housing attributes and property values (see Figure 2-2). The information is then utilized as described in the next section.

2.3 Step 3. Comparison of Housing Values in Each Neighborhood Pair

In this step, two approaches are used to determine the effect of airport noise on housing values—a subjective appraisal approach and a statistical regression modeling approach (see Figure 2-3).

2.3.1 Appraisal Approach

A number of local appraisers are contacted to select the individual best suited for this study. The appraisers are evaluated on several criteria, e.g., educational background, professional qualifications and experience, understanding of the problem, recommended approach, response to a survey of factors that influence home buyers, and fees.

The selected appraiser first performs conventional appraisals of each home selected in the previous phase of the study. For a given house, three similar and proximate recently sold houses are selected. External home inspections are

conducted to note such items as building code violations, quality of construction, and the general condition of the homes. The home under consideration is then compared to the three similar houses, and its value is adjusted for any significant differences.

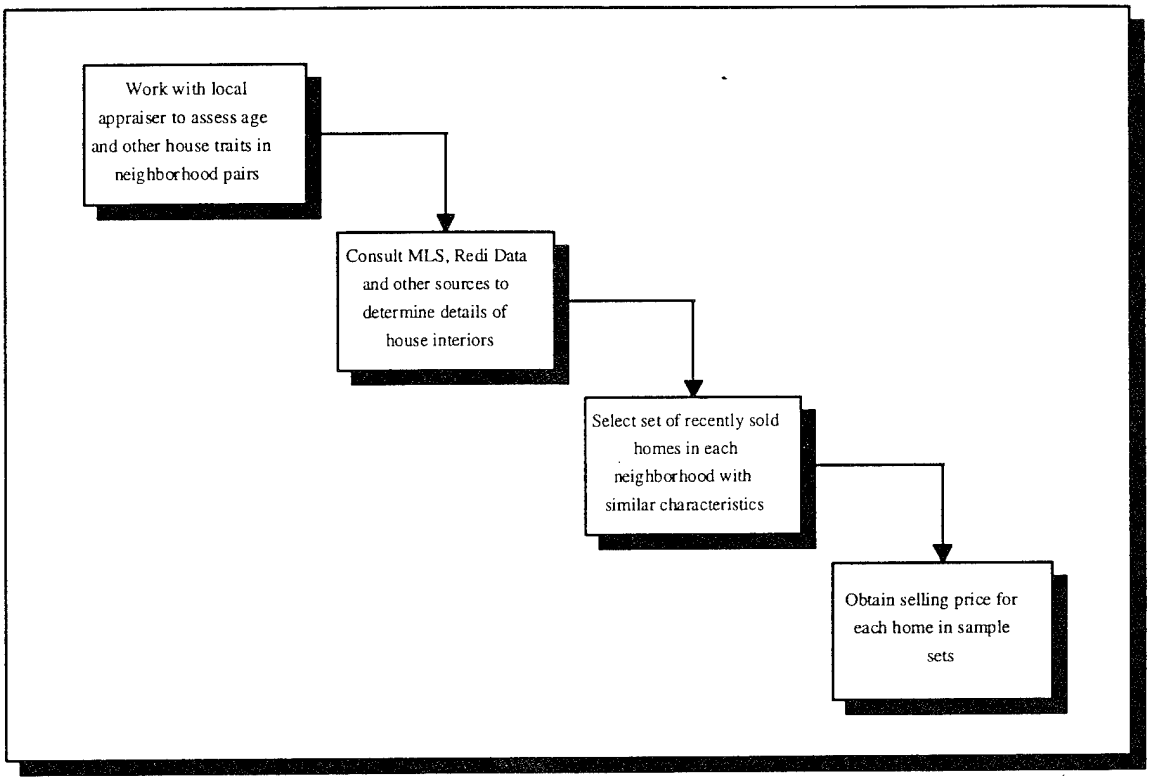

FIGURE 2-2. Selection of Sample Homes in Neighborhood Pair

The appraiser then selects two similar homes—one from the "noisy" neighborhood and one from the relatively quiet neighborhood—as "reference" homes. The appraised value of the reference home in the noisy neighborhood is adjusted to account for any significant difference from the reference home in the relatively quiet neighborhood (e.g., the two may be virtually identical except for a marginal difference in living area).

Finally, the values of the homes selected in each neighborhood are "normalized" by adjusting for any significant differences compared to the reference home in that particular neighborhood. Figure 2-4 depicts this normalization process. For example, the reference home may have certain characteristics such as a powder room on the main level, a car-port, but no living area in the basement. The appraiser uses current market conditions and experience to determine a dollar value for each of these (and other) amenities—that is, the amount that potential homebuyers would be willing to pay for these items (e.g., $1,500 for a powder room, $2,500 for a spare bedroom

in the basement, $5,000 for a two-car garage). The value of a home that has these items is accordingly increased; conversely, the price of a home that does not have these amenities is reduced appropriately.

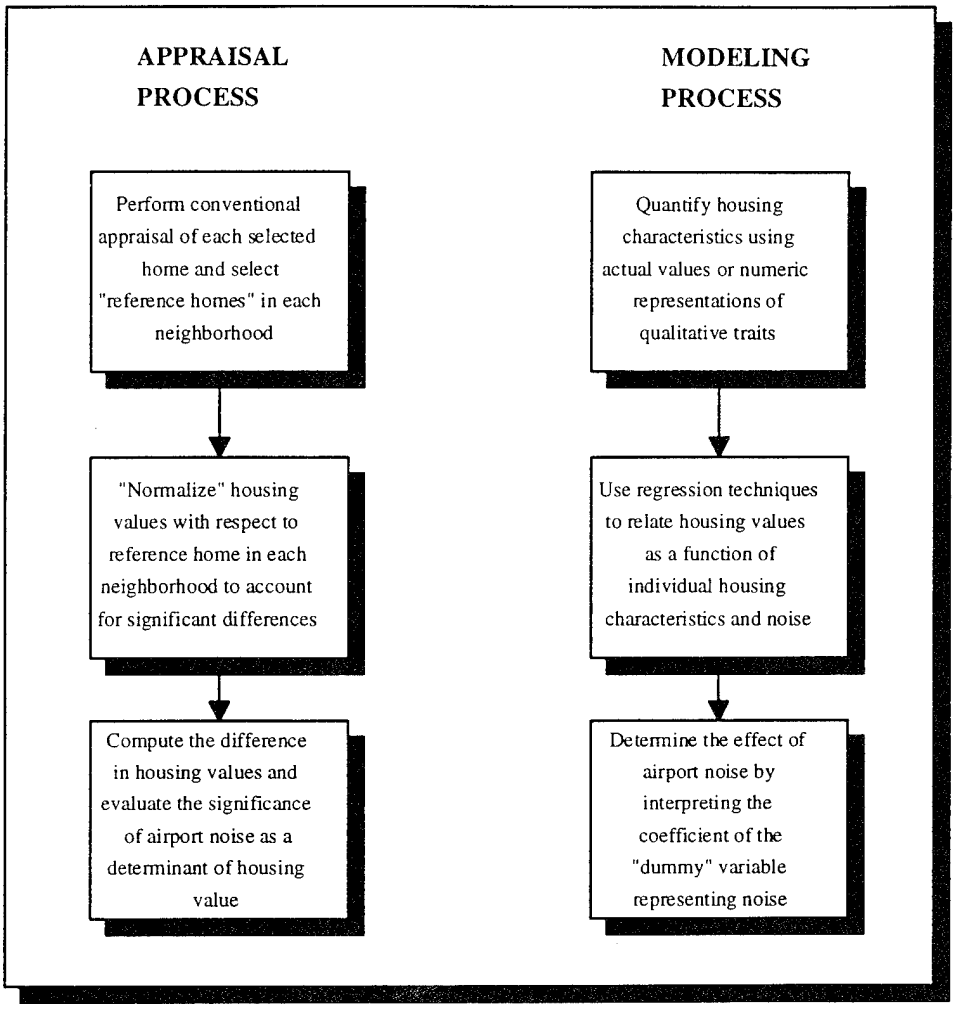

FIGURE 2-3. Determination of the Effect of Airport Noise on Housing Values

At the conclusion of the normalization procedure, the results for each neighborhood are tabulated and compared. The final results are then analyzed to determine the difference, if any, in housing values between noisy and quiet neighborhoods. This difference may be the consequence of airport noise.

2.3.2 Modeling Approach

This procedure utilizes multiple linear regression techniques to relate housing values with house characteristics and the noise levels to which they are exposed (a more complete discussion about regression techniques may be found

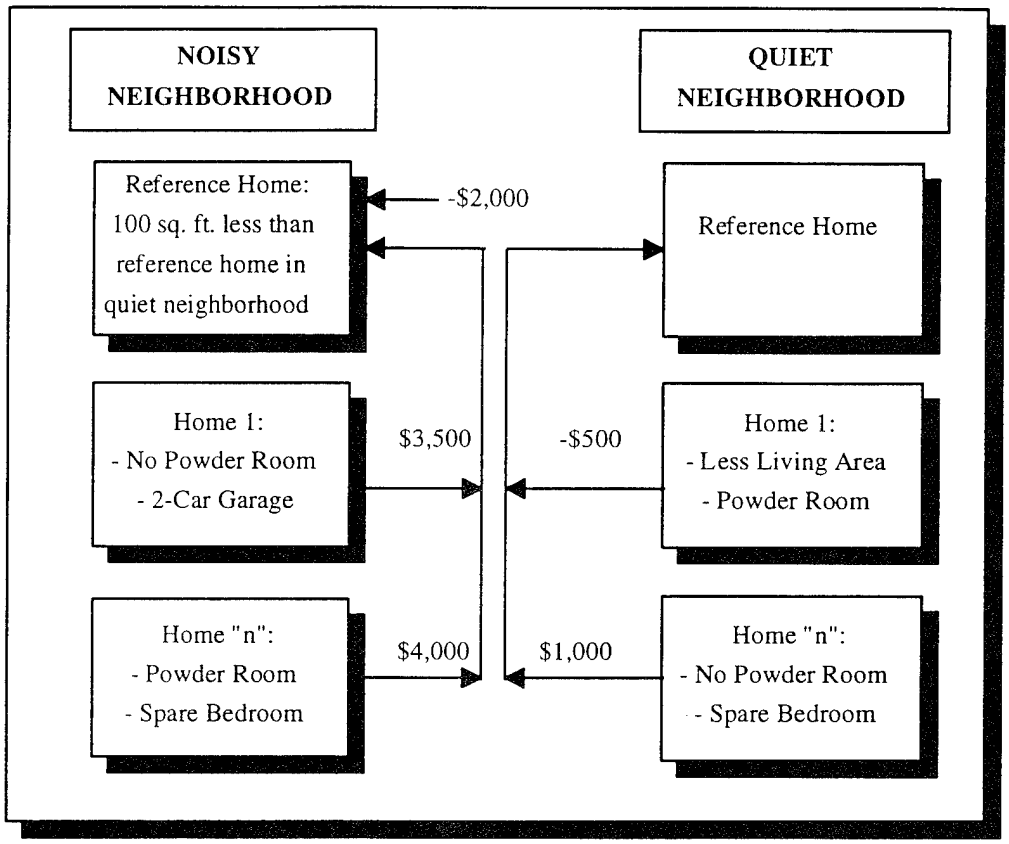

FIGURE 2-4. Example of "Normalization" of Housing Values

in most college level mathematics or statistics textbooks). The dependent variable is the selling price of each house, and the independent variables are the following individual house characteristics (numerical values are assigned to represent some of these traits):

- Age of the home
- Type of design (cape cod, split level, etc.,)
- Appraised condition of home (good, average, poor)
- Lot size (square feet)
- Number of bedrooms
- Number of bathrooms
- Total number of rooms
- Total living area (square feet)
- Number of garages
- Number of fireplaces
- Size of basement (full, three-quarter, half)
- Type of heating/cooling system.

In addition to these characteristics, the model also considers several "binary" variables, which take on a "yes/no" (or 1/0) value in performing the multiple regression analysis:

- Existence of swimming pool
- Existence of spa
- Existence of patio
- Existence of porch/deck.

Finally, a "dummy" variable is used to represent the two different levels of noise that were considered (for example, "0" for a home in a noisy neighborhood, "1" for a home in a relatively quiet neighborhood).

This technique yields a mathematical equation of the form:

Housing value = f(Housing characteristics, Noise)

After deriving a preliminary model using this procedure, a number of statistical tests and model parameters can be used to determine its validity. These tests and parameters include but are not limited to:

- Examination of R, the multiple correlation coefficient, and R^2, the coefficient of determination, which are measures of how well the regression model describes the data

- Computation of the "t"-statistic for each independent variable, which determines the significance of individual variables; that is, whether or not the variable contributes to predicting the dependent variable

- Determination of the "power," or sensitivity, of the regression, which is the probability that the model correctly describes the relationship between the variables, provided there is one

- Computation of the Durbin-Watson statistic, which is a measure of the correlation between the residuals.

The initial model is iteratively revised based on the results of these and other tests; for example, variables that are not statistically significant are dropped, and the model is reexamined to see if the power of the study improved. Collinearities are also eliminated to the extent possible. This process continues until no further refinement is possible.

Furthermore, the sign of the coefficients of all the variables considered must be examined to compare them for consistency with the appraiser's judgment. If the coefficient associated with the variable for living area is positive, then the

housing values are positively correlated with living area, as would be expected. A negative coefficient, on the other hand, would necessitate a closer examination of the data.

Finally, the coefficient of the variable used to represent noise is evaluated. Its numerical value establishes an upper bound for the monetary impact of airport noise on the price of the homes considered in the analysis.

2.3.3 Rationale for "Hybrid" Approach

A review of the past studies indicated that a purely statistical approach using regression modeling often gave disappointing results due to lack of adequate data, as well as the fact that all the variables that are considered by home buyers could not always be accounted for adequately.

On the other hand, a straightforward appraisal approach also leaves something to be desired, since it tends to be fairly qualitative and may be biased by the appraiser's subjective judgment and attitude toward the airport. Furthermore, the samples of homes exposed to different noise levels may differ significantly in terms of amenities offered and other individual traits—differences that may not be satisfactorily accounted for in the conventional appraisal process.

A hybrid approach that combined the desirable quantitative and qualitative aspects of both techniques was therefore devised. The conventional appraisal process was modified such that the values of the homes would be normalized to account for significant differences in house characteristics and thus enable a more reasonable comparison. This normalization procedure makes the conventional appraisal process much more quantitative.

The mathematical modeling approach uses data from samples that have already gone through a series of processes that are intended to isolate (to the extent possible) the effect of airport noise. Since this is done using the experience and judgment of local realtors and appraisers, some of the inherently subjective factors involved in the home buying process are explicitly incorporated into the selection of neighborhoods and sample homes used in the final regression model.

Therefore, the hybrid approach—a combination of a suitably modified appraisal process and statistical evaluation—was designed to overcome some of the shortcomings of the individual methods. In general, neither process is perfect in and of itself; rather, each one complements the other.

3. IMPLEMENTATION OF APPROACH

The three-step procedure described in the previous chapter was implemented in three metropolitan areas around the country. First, a pilot study was conducted around Baltimore/Washington International Airport (BWI) to evaluate the soundness of the methodology that was designed to quantify the effect of airport noise on property values—that is, to determine if it was practicable and reasonably economical to implement and to assess whether the data necessary for such studies are accurate and accessible enough to make future studies of this nature feasible.

An evaluation of the pilot study revealed that while the approach was reasonable and relatively easy to implement, the area around BWI is quite limited in terms of the number of residential neighborhoods impacted by noise and the range of property values. Therefore, the next study was conducted around Los Angeles International Airport (LAX), where much larger areas are impacted, and the homes are much more diverse.

The LAX study showed a distinct difference in results depending on the relative price range of the neighborhoods. Therefore, the third study was conducted around New York's John F. Kennedy International Airport (JFK) and La Guardia Airport (LGA) to see if the same effect was observable in similarly diverse neighborhoods (such as in the metropolitan New York area).

There were other advantages to considering these airports as well: they all had well documented and up-to-date information regarding noise impact areas, the metropolitan regions that they serve were only moderately affected by the economic changes of the past 4 years (relative to other areas), and they are located in communities that were not extremely sensitive to noise at the time.

This chapter describes how each study was executed, discusses the findings, and summarizes the overall project results.

3.1 The Baltimore/Washington International Airport (BWI) Pilot Study

The pilot study around BWI (Ref: 20) was performed in the Fall of 1990 to examine the efficacy of the analytical procedure. The results of each of the three steps in the analytical process are discussed below.

3.1.1 Neighborhood Identification (Step 1)

A pool of realtors from three top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the area around BWI. The general opinion (see Table 3-1) was that commuting distance, the

quality and proximity of recreational facilities, and the quality of local schools are the three most important criteria considered in the home-buying process around BWI.

TABLE 3-1. Results of Realtor Survey at BWI

Neighborhood Characteristics	Level of Importance
Commuting Distance	15.5
Quality/Proximity of Recreational Facilities	11.3
Quality of Local Schools	10.8
Racial/Social/Ethnic Characteristics	10.3
Crime Rate	10.0
Local Traffic Conditions/Congestion	8.8
Property Taxes	8.8
Quality of Neighboring Residences	8.3
Proximity of Commercial/Shopping Centers	7.3
Quality of Municipal Services	6.0
Access to Public Transportation	3.0
Total	100.0

A norm realtor whose results approximated the average survey results was selected from the pool of realtors. This individual helped choose a suitable neighborhood pair in the vicinity of BWI. The only areas with reasonably sized residential neighborhoods are to the east and southeast of BWI, with the latter exposed to high levels of airport noise. The "noisy" Glen Burnie Park neighborhood was exposed to a DNL of 72 dB, while the "quiet" Southgate neighborhood was exposed to a DNL of 61 dB (see Appendix A).

3.1.2 Sample House Selection (Step 2)

A total of 30 homes was selected (15 in each neighborhood); a minimum sample size of 22 homes was required for statistical analysis. The selection was done using the MLS and other sources.

The amenities offered by each home were roughly similar across neighborhoods. However, after preliminary inspections by the appraiser, one home in the quiet neighborhood and two in the noisy neighborhood were excluded from the study because of their unique characteristics.

The average sale price in the quiet neighborhood was $126,460, while the average sale price in the noisy neighborhood was $118,960—$8,000 less than that in the quiet neighborhood.

The difference between the selling price and the appraised value of each home was marginal—the appraised value was $1,538 higher than the sale price in the noisy neighborhood and only $397 higher than the sale price in the quiet neighborhood.

3.1.3 Housing Value Comparison (Step 3)

3.1.3.1 Appraisal Approach

The appraiser applied the conventional appraisal process for all the homes in the study. Based on these appraisals, one reference home was chosen in each of the selected neighborhoods.

The normalization process (as described in Section 2.3.1) was then performed for all the homes in each neighborhood. The adjustments made to the property values ranged from -$6,600 to +$14,700. The average adjusted appraised values were then compared to determine the effect of airport noise on housing values. These values were $125,879 in the quiet neighborhood and $125,262 in the noisy neighborhood.

The adjusted appraised values suggested an average $617 higher property value in the quiet neighborhood—a minimal amount that is difficult to characterize as a direct consequence of airport noise. Table 3-2 summarizes these results. The difference between the unadjusted property values and the adjusted, or normalized, values is significant, indicating considerable differences in the amenities offered across the neighborhoods.

Table 3-2. Summary of Appraisal Approach Implemented at BWI

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
DNL, dB	72	61	11	N.A.	N.A.	N.A.
Value (unadj.)	$120,538	$126,857	-$6,319	-5.0%	-$574	-0.45%
Value (adj.)	$125,262	$125,879	-$617	-0.5%	-$56	-0.04%

3.1.3.2 Modeling Approach

The multiple regression model developed for BWI used appraised values as the dependent variable, since these were virtually identical to the sale price of each home. Table 3-3 shows the final model, which considered only those independent variables that were statistically significant.

TABLE 3-3. Linear Regression Model Developed for BWI

$$Y = 41331 + 673X_1 + 8065X_2 + 6885X_3 + 7726X_4 + 2848X_5 + 4718X_6 + 8493X_7 + 5706X_8 + 4984X_9 - 14596X_{10}$$

Y =	Appraised Value
X_1 =	Age of House
X_2 =	Overall Condition of House (average, good)
X_3 =	Total Number of Rooms
X_4 =	Basement (Full, Partial, None)
X_5 =	Garage (2-car, 1-car, None)
X_6 =	Deck (Yes, No)
X_7 =	Pool (In-ground pool, None)
X_8 =	Patio (Yes, No)
X_9 =	Fireplace (Yes, No)
X_{10} =	Dummy Variable (Quiet, Noisy)

$R^2 = 0.91$
F-statistic < 0.0001
t-statistics for independent variables: all significant at 75% confidence level

The dummy variable representing the two different levels of noise was a significant contributor and suggested that airport noise decreased the property values in the BWI area by $14,595—that is, if the two neighborhoods were truly identical in every respect other than noise levels, the $14,595 difference could be attributed to airport noise.

3.1.4 Analysis of Results of the BWI Pilot Study

The primary finding of this pilot study was that the analytical procedure is viable and reasonably economical to implement. Furthermore, the data required are reasonably accessible to a sufficient level of detail. However, the residential areas of interest were quite small, and the range of property values in these areas was very narrow.

Both the appraisal approach and the modeling approach indicated that airport noise has some effect on housing values. The magnitude of the impact computed using the appraisal process was negligible ($627), while the model suggests a maximum bound for this impact ($14,595).

These results must be viewed in light of some unique traits that were observed in the areas around BWI. First, the Glen Burnie neighborhood has a significant proportion of residents who are second-generation owners of the same property. Second, many of the residents are employed directly or

indirectly by the airport. Hence, the market for these homes is driven more by homebuyer needs than wants; e.g., buyers are willing to trade off increased airport noise with decreased commuting distance.

Finally, the modeling process was constrained by virtue of the limited size of the population from which the sample homes were chosen. All these factors had some bearing on the overall study results.

3.2 The Los Angeles International Airport (LAX) Study

The study around LAX (Ref: 21) was performed in the Summer of 1991. This study was intended primarily to implement the analytical approach around an airport with a substantially larger number of residential areas to choose from (compared to BWI) and to see if the diversity of property values had any bearing on the overall results.

The results of each of the three steps in the analytical process are given below. It should be noted that this study used CNEL (Community Noise Exposure Level) instead of DNL to quantify noise impact, since all California airports use this metric to determine airport noise levels. It is similar to the DNL, except for an additional penalty for evening operations. Thus, CNEL contours tend to be larger than DNL contours. Since these contours were used primarily to identify areas with different noise exposure, the use of CNEL made no significant difference to this study.

3.2.1 Neighborhood Identification (Step 1)

A pool of 11 realtors from five top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the Los Angeles area. The crime rate and the quality of local schools (see Table 3-4) were determined to be the two most important criteria considered in the homebuying process around LAX.

A norm realtor whose results approximated the average survey results was selected from the pool of realtors. The area around LAX is quite diversified, with prices ranging from $115,000 to $369,000. Thus, it was possible for the norm realtor to choose two neighborhood pairs in the vicinity of LAX—one in moderately-priced areas, the other in relatively low-priced areas. One neighborhood in each pair was exposed in a high noise level relative to the other.

The moderately-priced neighborhoods selected were to the north of the airport (see Appendix B):

- West Westchester, located in a CNEL contour of 69 dB
- Kentwood, located in a CNEL contour of 55 dB.

TABLE 3-4. Results of Realtor Survey at LAX

Neighborhood Characteristics	Level of Importance
Crime Rate	20.9
Quality of Local Schools	15.4
Quality of Neighboring Residential Units	10.5
Racial/Social/Ethnic Characteristics	9.2
Quality/Proximity of Recreational Facilities	8.7
Local Traffic Conditions/Congestion	8.7
Commuting Distance	8.0
Quality of Municipal Services	7.5
Proximity of Commercial/Shopping Centers	5.1
Access to Public Transportation	3.6
Property Taxes	2.4
Total	100.0

The low-priced neighborhoods selected were to the east of the airport:

- North Inglewood, located in a CNEL contour of 72 dB
- South Inglewood, located in a CNEL contour of 60 dB.

3.2.2 Sample House Selection (Step 2)

A total of 48 homes was selected (12 in each neighborhood) using the MLS and other sources. The objective was to select recently sold homes with similar amenities across each neighborhood pair. However, it was observed that even though market values in the Kentwood area were higher than Westchester, the majority of homes were of lesser quality with fewer amenities.

In the moderately-priced neighborhoods, the average sale price in the quieter Kentwood area was $58,625 higher than the West Westchester homes. In the low-priced neighborhoods, the average sale price in the quieter South Inglewood area was $14,125 higher than the North Inglewood area.

3.2.3 Housing Value Comparison (Step 3)

3.2.3.1 Appraisal Approach

The appraiser applied the conventional appraisal process for all the homes in the study. Based on these appraisals, one reference home was chosen in each of

the selected neighborhoods, and their values were adjusted for any differences in amenities and style.

The normalization process was performed for all the homes in each neighborhood. The adjustments made to the prices of moderately-priced homes ranged from -$20,400 to +$32,700. The adjustments made to the prices of low-priced homes ranged from -$12,520 to +$28,360.

The average adjusted appraised values were then compared within each price category to determine the effect of airport noise on housing values. In the moderately-priced areas, these values were $387,565 in the quiet neighborhood, and $326,692 in the noisy neighborhood. In the low-priced areas, these values were $158,909 in the quiet neighborhood, and $157,641 in the noisy neighborhood.

Thus, in the moderately-priced areas, the adjusted appraised values suggest an average $60,873 (18.6 percent) higher property value in the quiet neighborhood, or $4,348 (1.33 percent) per dB of "additional quiet." On the other hand, the results in the low-priced areas are much more modest—a $1,268 (0.8 percent) higher property value in the quiet neighborhood.

Tables 3-5 and 3-6 summarize these results. The difference between the unadjusted property values and the adjusted, or normalized values is significant in the low-priced neighborhoods, indicating considerable differences in the amenities offered across the neighborhood pair.

TABLE 3-5. Summary of Appraisal Approach Implemented at LAX: Low-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
CNEL, dB	72	60	12	N.A.	N.A.	N.A.
Value (unadj.)	$157,208	$171,333	-$14,125	-8.2%	-$1,177	-0.69%
Value (adj.)	$157,641	$158,909	-$1,268	-0.8%	-$106	-0.07%

TABLE 3-6. Summary of Appraisal Approach Implemented at LAX: Moderately-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
CNEL, dB	69	55	14	N.A.	N.A.	N.A.
Value (unadj.)	$321,750	$380,375	-$58,625	-15.4%	-$4,188	-1.10%
Value (adj.)	$326,692	$387,565	-$60,873	-15.7%	-$4,348	-1.12%

3.2.3.2 *Modeling Approach*

Two multiple linear regression models were developed for LAX using sale price as the dependent variable. Table 3-7 shows the final models.

TABLE 3-7. Linear Regression Models Developed for LAX

Moderately-priced Neighborhoods	Low-priced Neighborhoods
$Y = 303858 - 15614X_1 + 24909X_2 + 22.28X_3 + 44792X_4 + 61916X_5$	$Y = 141761 + 2842X_1 + 6992X_2 + 9680X_3 + 9652X_4 + 6146X_5 + 639X_6$
Y = Sale Price X_1 = Design (traditional bungalow, frame, rustic, mediterranean) X_2 = Condition (average, good) X_3 = Living area X_4 = Pool (Yes, No) X_5 = Dummy Variable (Quiet, Noisy)	Y = Sale Price X_1 = Design (traditional bungalow, frame, rustic, mediterranean) X_2 = Condition (average, good) X_3 = Basement (Yes, No) X_4 = Garage (2-car, 1-car, None) X_5 = Fireplace (2 fireplaces, 1 fireplace, None) X_6 = Dummy Variable (Quiet, Noisy)
$R^2 = 0.83$ F-statistic < 0.001 t-statistics for independent variables all significant at 0.85	$R^2 = 0.47$ F-statistic < 0.066 t-statistics for independent variables varied

For the moderately-priced neighborhoods, the model developed provided a "good fit" between the selling price and housing characteristics. The model indicated that if the two neighborhoods were identical, then the presence of airport noise decreased housing value by an average of $61,916, or 19 percent. Model parameters also supported its validity.

The model for the low-priced neighborhoods did not provide a similar good fit. Although it did indicate a marginal effect ($639) of noise on property values, most of the model parameters did not support its validity.

3.2.4 Analysis of Results of the LAX Study

Both the appraisal approach and the modeling approach indicated that airport noise has an impact on housing values. The main finding, however, was that

this effect is much more noticeable in the moderately-priced areas than in the low-priced areas, where the effect is very small.

There were several unique local factors that became apparent during the appraisal process. First, the market for low-priced homes was dominated by the desire to own a home, rather than specific neighborhood characteristics such as noise, which was, in many cases, not a serious consideration. Second, homebuyers in the Westchester area were willing to live with higher noise levels in return for homes that cost less and had more amenities than comparable ones in the quieter Kentwood area.

Third, there had been a significant downturn in the local economy in the year prior to the study, which was reflected in terms of depressed real estate values. Thus, in many cases the study compared properties that were sold up to a year apart. All these factors had some impact of the overall results.

3.3 The Study at New York Metropolitan Airports

The study in the New York metropolitan area (Ref: 22) was performed in 1993, and considered areas impacted by La Guardia (LGA) and John F. Kennedy International (JFK) airports. This study was designed to test whether the principal finding of the LAX analysis—that the impact of airport noise is more pronounced in high-priced neighborhoods—could be observed in a comparable environment.

The metropolitan New York area ideally suited this purpose, since it is similar to LAX in terms of the size and density of residential communities, and the housing values encompass a fairly broad range. The results of each of the three steps in the analytical process are given below.

3.3.1 Neighborhood Identification (Step 1)

A pool of 18 realtors from a number of top real estate agencies was surveyed to assess neighborhood characteristics and their relative importance in the area around LGA and JFK. The quality of local schools and the crime rate (see Table 3-8) were determined to be the two most important criteria considered in the home buying process in this area—exactly those weighed in the Los Angeles area.

A norm realtor whose results approximated the average survey results was selected from this pool. Given the diversified nature of the residential communities affected by these airports, the norm realtor could choose three neighborhood pairs in the New York area—the first in high-priced areas, the

second in moderately-priced areas, and a third in relatively low-priced areas. One neighborhood was exposed to a high noise level relative to the other.

Although the areas impacted by these airports' operations are quite large, the residential areas for which reliable sales (and other) data were available were limited to two communities around JFK (Valley Stream and Five Towns) and only one community around LGA (Flushing). Consequently, the difference in noise levels for the quiet and noisy neighborhoods were not as high as desired.

The high-priced neighborhoods (see Appendix C-1) selected were impacted by JFK operations:

- Northern Five Towns, exposed to a DNL of approximately 67 dB
- Southern Five Towns, exposed to a DNL of about 63 dB.

TABLE 3-8. Results of Realtor Survey in Metropolitan New York Area

Neighborhood Characteristics	Level of Importance
Quality of Local Schools	16.3
Crime Rate	15.9
Quality of Neighboring Residential Units	12.4
Access to Public Transportation	11.3
Commuting Distance	9.7
Property Taxes	8.9
Racial/Social/Ethnic Characteristics	8.2
Proximity of Commercial/Shopping Centers	6.3
Quality of Municipal Services	6.1
Local Traffic Conditions/Congestion	2.8
Quality/Proximity of Recreational Facilities	2.1
Total	100.0

The low-priced neighborhoods (see Appendix C-2) selected were also impacted by JFK operations:

- South Valley Stream, located in a DNL contour of about 67 dB
- North Valley Stream, located in a DNL contour of about 63 dB.

The moderately-priced neighborhoods (see Appendix C-3) selected were impacted by LGA operations:

- Southwest Flushing, located in a DNL contour of about 73 dB
- Northeast Flushing, located in a DNL contour of about 63 dB.

3.3.2 Sample House Selection (Step 2)

A total of 90 homes (15 in each neighborhood) with roughly similar amenities were selected using the MLS, Redi Data, and other sources.

In the low-priced neighborhoods, the average sale price of homes in the quieter North Valley Stream area was $900 higher than the South Valley Stream homes. In the moderately-priced neighborhoods, the average sale price in the quieter Northwest Flushing area was $18,933 higher than the Southeast Flushing area. Finally, in the high-priced neighborhoods, the average sale price in the quieter Southern Five Towns area was $74,000 higher than the Northern Five Towns area.

3.3.3 Housing Value Comparison (Step 3)

3.3.3.1 Appraisal Approach

The appraiser applied the conventional appraisal process for all the homes in the study. Based on these appraisals, one reference home was chosen in each of the selected neighborhoods, and their values were adjusted for any differences in amenities and style.

The normalization process was performed for all the homes in each neighborhood. The adjustments made to the prices of low-priced homes ranged from -$31,500 to +$38,000. The adjustments made to the prices of moderately-priced homes ranged from -$4,500 to +$28,000. The adjustments made to the prices of high-priced homes ranged from -$95,500 to +$35,500.

The average adjusted appraised values were then compared within each price category to determine the effect of airport noise on housing values. In the low-priced areas, these values were $148,767 in the quiet neighborhood, and $148,033 in the noisy neighborhood. In the moderately-priced areas, these values were $231,100 in the quiet neighborhood, and $220,400 in the noisy neighborhood. In the high-priced areas, these values were $414,000 in the quiet neighborhood, and $391,633 in the noisy neighborhood.

As was observed in the LAX study, the results in the low-priced areas indicate virtually no ($733, or 0.5 percent) difference in property values between the quiet and noisy neighborhoods. In the moderately-priced areas, the adjusted appraised values suggest an average $10,700 (4.9 percent) higher property value in the quiet neighborhood, or $1,070 (0.5 percent) per dB of additional quiet. In

the high-priced areas, the adjusted appraised values suggest an average $22,367 (5.7 percent) higher property value in the quiet neighborhood, or $5,474 (1.4 percent) per dB of additional quiet.

Tables 3-9 through 3-11 summarize these results. The difference between the unadjusted property values and the adjusted, or normalized, values is again significant, this time in the moderately- and high-priced neighborhoods (as opposed to the low-priced areas in the LAX study), indicating considerable differences in the amenities offered across each neighborhood pair.

TABLE 3-9. Summary of Appraisal Approach Implemented at JFK: Low-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
DNL, dB	67	63	4	N.A.	N.A.	N.A.
Value (unadj.)	$158,500	$159,400	-$900	-0.6%	-$225	-0.14%
Value (adj.)	$148,033	$148,767	-$734	-0.5%	-$184	-0.12%

TABLE 3-10. Summary of Appraisal Approach Implemented at LGA: Moderately-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
DNL, dB	73	63	10	N.A.	N.A.	N.A.
Value (unadj.)	$213,067	$232,000	-$18,933	-8.2%	-$1,893	-0.82%
Value (adj.)	$220,400	$231,100	-$10,700	-4.6%	-$1,070	-0.46%

TABLE 3-11. Summary of Appraisal Approach Implemented at JFK: High-Priced Neighborhoods

ITEM	Neighborhood		Difference	% Difference	Difference Per dB	% Differ. Per dB
	Noisy	Quiet				
DNL, dB	67	63	4	N.A.	N.A.	N.A.
Value (unadj.)	$385,500	$459,500	-$74,000	-16.1%	-$18,500	-4.03%
Value (adj.)	$391,633	$414,000	-$22,367	-5.4%	-$5,592	-1.35%

3.3.3.2 Modeling Approach

The three multiple regression models developed for the New York metropolitan airports used sale price as the dependent variable. Table 3-12

shows the final models. In all three models, the sign of some of the coefficients were contrary to the appraiser's judgment.

For the moderately-priced neighborhoods, the model developed did not provide a reasonable fit between the selling price and six selected housing characteristics, and some of the independent variables were not significant contributors to the model.

For the low-priced neighborhoods, the model developed provided a reasonable fit between the selling price and five selected housing characteristics. The model indicated that if the two neighborhoods were identical, then the presence of airport noise decreased housing value by an average of $724—a negligible amount. Most of the independent variables, except the dummy variable, were significant contributors to the model.

The model for the high-priced neighborhoods provided a reasonable fit between the selling price and five selected housing characteristics. The model indicated that if the two neighborhoods were identical, then the presence of airport noise decreased housing value by an average of $20,224, or 5 percent.

TABLE 3-12. Linear Regression Models Developed for LGA and JFK

High-Priced Neighborhoods	Moderately-Priced Neighborhoods	Low-Priced Neighborhoods
$Y = 275866 + 1261X_1 + 5.95X_2 + 2757X_3 + 130X_4 + 20224X_5$	$Y = 218118 + 967X_1 + 6.82X_2 + 2782X_3 + 0.62X_4 - 9413X_5 + 14918X_6$	$Y = 106342 - 393X_1 + 6399X_2 + 34X_3 + 8764X_4 + 724X_5$
Y = Sale Price X_1 = Age of House X_2 = Lot Size X_3 = Total Number of Rooms X_4 = Type of Basement (Full, Partial, None) X_5 = Dummy Variable (Quiet, Noisy)	Y = Sale Price X_1 = Age of House X_2 = Lot Size X_3 = Total Number of Rooms X_4 = Living Area X_5 = Garage (Yes, No) X_6 = Dummy Variable (Quiet, Noisy)	Y = Sale Price X_1 = Age of House X_2 = Number of Bedrooms X_3 = Living Area X_4 = Type of Basement (Full, Partial, None) X_5 = Dummy Variable (Quiet, Noisy)
$R^2 = 0.77$ F-statistic < 0.001 t-statistics for independent variables varied	$R^2 = 0.57$ F-statistic < 0.138 t-statistics for independent variables varied	$R^2 = 0.73$ F-statistic < 0.002 t-statistics for independent variables varied

3.3.4 Analysis of Results of the New York Study

The New York study gave similar results to those at LAX—airport noise has a greater effect on housing values in higher-priced areas than it does at relatively lower-priced ones. The impact was hard to detect in the low-priced neighborhood pairs and was significant in the high-priced neighborhoods. The models that were developed gave mixed results.

The study also showed that while the information needed to perform such an analysis is generally available, this may not always be the case. The residential areas impacted by airport operations around JFK for which reliable sales data (as well as details about each home) were available were limited to two communities—Valley Stream and Flushing. Similarly, the only community around LGA for which sufficient sales data were available was the Flushing area. Consequently, the differences in noise levels for the low- and high-priced neighborhood pairs were smaller than those used in the previous studies.

The number of residential property sales in the selected neighborhoods was limited due to an extremely "soft" local real estate market, and properties that were sold as much as 18 months apart were considered in the analysis. This slow market was particularly pronounced in the high-priced Five Towns area; as a result, the study was forced to compare homes in the noisy neighborhood that were significantly smaller than those in the quiet neighborhood. All these factors had some impact of the overall results.

3.4 Summary of Results

The main conclusions of the studies conducted at BWI, LAX, LGA, and JFK may be summarized as follows:

- The analytical approach is relatively easy and economical to implement.
- The procedure is repeatable and verifiable, and the data required are generally accessible.
- The normalization procedure is crucial to assuring a fair comparison across a neighborhood pair; a simple comparison of average appraised values without normalizing will lead to erroneous conclusions.
- The impact of airport noise varies from negligible to significant and appears to be more pronounced in higher-priced neighborhoods than in neighborhoods where housing is relatively less expensive.

- The magnitude of the impact of airport noise on housing values cannot be estimated at the national level at this time, since the impact results varied across a wide range, and only a small sample of airports was considered.

As mentioned earlier, these studies were not intended to obtain precise values of the noise impact at the individual airports, but rather used these airports as sites for assessing a methodology to measure this impact. The methodology was found to the most promising of those considered thus far, and is relatively easy to implement. There are several approaches that may be used to implement this methodology for a nationwide examination of the impact of airport noise on housing values. These alternative approaches are discussed in the next chapter.

4. ALTERNATIVES FOR FURTHER STUDY

The studies discussed in this report were performed in three metropolitan areas to test the effectiveness of an analytical approach to measure the impact of airport noise on housing values. At this time, the magnitude of this impact cannot be estimated at the national level, given the wide variation in the study results and the fact that only four airports were considered.

However, the approach was found to be credible and relatively easy to implement and could be used for a national level examination of the impact of airport noise on housing values. Such an assessment will help decision makers to better understand an inherently complex issue and will quantify the ranges of the impact such that national policy or guidelines on how to deal with this issue can be considered.

To perform an evaluation at the national level, two important questions must be resolved:

1. Which communities that are affected by airport operations should be considered where the neighborhood pair model may be implemented?

2. What is the appropriate number of these communities that must be considered for the evaluation to be valid?

Both these issues are interrelated, and this chapter describes methods of addressing them so that the effect of airport noise on housing values may be assessed at the national level.

4.1 Determination of Airports to Be Considered

The sample of airports that must be considered for a national level study must clearly include communities that are representative of the impacted population in general. However, U.S. airports and the communities affected by their operations vary considerably in terms of size, populations impacted, and other characteristics. Hence, it is possible to classify them into different categories to test different hypotheses, as described below. One of two alternative methods (see Section 4.2) could then be used to determine the appropriate number of communities that need to be considered in each category, and representative airports within each category would be selected for implementing the neighborhood pair model.

If the sample sizes are correctly chosen, and studies at the representative airports are conducted using the appropriate numbers of neighborhood pairs and noise levels, it is likely that anomalies due to local conditions as well as

confounding effects (such as variations in property values with interest rate fluctuations) will average out, and the resulting magnitude of airport noise impact will "regress towards the mean" for a given category.

4.1.1 Analysis Based on Airport Size

The studies described earlier focused on fairly large airports. It is unclear how airport noise would affect housing values in communities around medium and small airports. This approach would attempt to clarify this.

First, airports would be classified by size. One such classification is available in the Nationwide Noise Impact Model, or NANIM (Ref: 19), which categorizes all the U.S. airports into the following five broad classes based on the number of operations at each airport and the flying range of the aircraft:

- Large, long range
- Large, medium range
- Large, short range
- Medium, short range
- Small, short range.

After selecting a statistically significant sample of airports in each category (as described in the next section), the neighborhood pair model could be applied around each airport, ideally using larger sample sizes and a wider range of noise levels. This would provide a more accurate determination of the relationship of property values and airport noise for each airport category.

4.1.2 Analysis Based on Economic Status of Communities

The studies described above examined the issue of airport noise in largely metropolitan areas. However, its impact in more diverse settings is not known. This approach would first classify airports on the basis of the local economic conditions around the airports.

It would be necessary to first perform a survey to determine the current economic conditions of communities around airports nationwide. The survey would use property values as an indicator of local economic conditions, since these are well documented and generally easily accessible. The survey would classify all the domestic airports on the basis of the value of residential real estate in areas impacted by airport operations—for example, "low" for those with neighborhood property values below $150,000, "moderate" for those within $150,000-$300,000 range, "high" for those greater than $300,000.

After selecting a statistically significant sample of airports in each category (as described in the next section), the neighborhood pair model could be applied around each airport, ideally using larger sample sizes and a wider range of noise levels. This would provide a more accurate determination of the relationship of property values and airport noise for each airport category.

4.1.3 Analysis Based on Airports as Employment Centers

The role that an airport plays as a source of livelihood can significantly affect its perception in the neighboring communities. If noise was not a concern, property values should decline with increased distance from the airport because of increased commuting costs. Since airport operations do result in noise pollution, neighborhoods must balance increased noise with reduction in commuting costs.

The magnitude of this trade-off may be tested at a national level. It would first be necessary to determine the importance of airports nationwide as an employer in those areas affected by airport operations. The domestic airports could then be classified on the basis of proportions of affected population that derive primary income from the airport (or airport-related activity); for example, "low" for communities where less than 20 percent work for the airport, "moderate" for those with 20-50 percent, "high" for those greater than 50 percent.

After selecting a statistically significant sample of airports in each category (as described in the next section), the neighborhood pair model could be applied around each airport, ideally using larger sample sizes and a wider range of noise levels. This would provide a more accurate determination of the relationship of property values and airport noise for each airport category.

4.1.4 Analysis of Airport Closures

The recent closures of commercial airports as well as the military base realignments could be used advantageously to examine the effect of airport noise on property values. While these events are currently not frequent enough to be used to perform national level studies, they nonetheless have the potential for shedding more light on this issue.

For example, if an airport has recently ceased operations, or if its closure is imminent (such as Denver Stapleton), the following approach may be used: use historical property values for selected neighborhood pairs in the (previously) noisy/less noisy areas to compile a statistically significant data set; obtain the most current property value information for these same neighborhood pairs; adjust these data for exogenous factors that may have resulted in changes in the

property values—changes in purchasing power, interest rate fluctuations, or loss of a significant employer (the airport), and finally, express both sets of data in consistent units (for example, 1994 dollars) after making these adjustments. Any difference in the property values before and after the airport closure could possibly be attributed to being associated with airport noise.

While previous studies have generally dealt with the issue of the adverse effect of increased noise levels on property values, it is unknown whether the reverse effect is true—that is, if property values increase as noise levels decrease. This approach may also help in examining this aspect of airport noise impact.

4.2 Determination of the Number of Airports to Be Considered

Ideally, the neighborhood pair model should be used at all the airports around the country to get the most accurate estimate of the effect of airport noise on housing values. This clearly is not feasible given the amount of resources that it would necessitate. Instead, a less expensive approach would be to perform similar studies for each airport category at a number of airports that is determined using the approaches described below.

4.2.1 Steady State Approach

One approach is to systematically implement the neighborhood pair model for each member of a given category of domestic airports or affected communities (as described in the previous section). Initially, there will inevitably be some variation in the noise impact. As more airports are examined, this variation averaged over all the airports will gradually tend to become smaller (see Figure 4-1). In other words, with every additional airport that is examined, the average noise impact will vary less and less from the theoretical mean value, or will come closer to "steady state." At some point, it will be observed that adding another airport's results makes virtually no difference to the average impact, and this average value will be the noise impact for the category of airports or communities being evaluated.

4.2.2 Statistical Approach

The steady state approach, while feasible, could prove to be economically impractical to implement. A second, more cost-effective approach would use standard statistical procedures to determine how many neighborhood pairs would be required for each category of airports. This number depends on the total population of airports and the acceptable levels of confidence, or the

probability that a "Type I" or "Type II" error may occur*. The extent of these errors that are considered tolerable will determine the size of the sample. In general, the lower the error permissible, the larger the sample size.

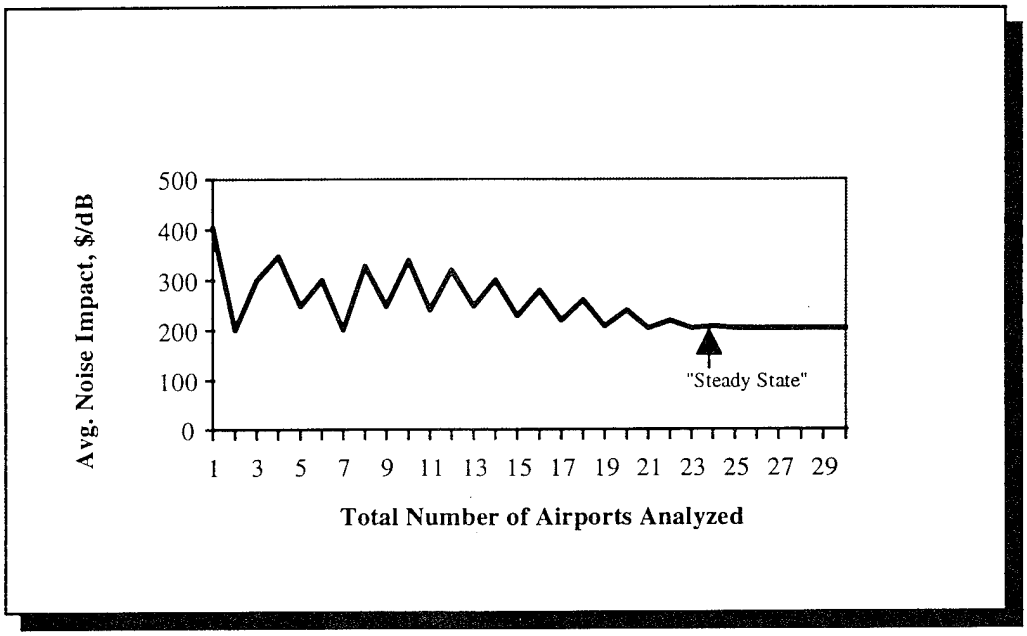

Figure 4-1: Illustration of "Steady State" Approach

Thus, the neighborhood pair model could be applied around a statistically significant sample of affected communities in each category, and a more accurate determination could be made of the relationship of property values and airport noise.

* In this case, a Type I error refers to the probability of concluding that housing values for lower levels of noise are higher than those at higher levels of noise when, in fact, they are not; a Type II error is the probability of concluding that there is no significant difference in housing values when, in fact, there is.

5. SUMMARY AND CONCLUSIONS

An analytical approach was designed to estimate the effect of airport noise on housing values. The procedure consists of three steps: 1) identification (by a local realtor) of two neighborhoods that have similar characteristics except for noise levels, 2) selection of a sample of houses from each neighborhood with reasonably similar individual housing characteristics, and 3) use of a modified appraisal process (by a local appraiser) and statistical modeling to compare the housing values in the two neighborhoods.

The local appraiser's and realtor's subjective inputs are explicitly incorporated in the neighborhood and home selection process and are useful in interpreting the modeling results. Conversely, asking the appraiser to normalize the sale prices of the selected homes to account for differences in house characteristics makes the appraisal procedure much more quantitative compared to conventional appraisals. Hence, the analytical approach was designed to minimize the effects of local conditions by using local expertise and a combination of quantitative and qualitative techniques that complement each other, and seeks to overcome the shortcomings of previous studies that exclusively used one technique or the other.

A series of studies was performed around four major airports—Baltimore-Washington International Airport (BWI), Los Angeles International Airport (LAX), New York La Guardia Airport (LGA), and New York John F. Kennedy International Airport (JFK)—to test the efficacy of this approach, to see if any distinct trends could be observed, and to determine if any inferences could be made at the national level regarding the impact of airport noise on housing values.

The results of the studies indicate that the neighborhood pair model is viable and helps establish the boundaries of the effect that airport noise has on housing values at a given airport. The observed trends are consistent, showing that the noise impact is more pronounced in higher-priced areas and is hard to detect in relatively low-priced neighborhoods. However, the magnitude of this impact cannot be estimated at the national level at this time, since the results varied across a wide range for the airports studied, and only a small sample of airports was considered.

The focus of these studies was not to examine the issue of airport noise impact in detail at the local level*. Rather, the primary objective of these studies was to assess the feasibility of a method to examine the effects of airport noise on property values. The studies indicate that the methodology is viable and reasonably economical, and there are several approaches that may be used to implement this technique for a nationwide examination of the impact of airport noise on housing values.

These evaluations could be performed by first classifying airport communities in one (or more) of several ways, including on the basis of airport size, economic status of the adjacent residential areas, and the importance of the airport as a local employer. Statistical techniques can be used to establish the appropriate number of neighborhoods and airports at which the neighborhood pair model must be implemented.

If the sample size is correctly chosen, and studies at the representative airports are conducted using the appropriate numbers of neighborhood pairs and noise levels, anomalies due to local conditions and confounding factors will tend to average out, and the magnitude of impact of airport noise on housing values for categories of airports can be determined. The results of such an evaluation could help decision makers in formulating national policy or guidelines regarding this issue and would enable local airport authorities to better deal with airport noise impact.

* For any given airport, a more precise estimate of the elasticity of property values with respect to airport noise could be made by explicitly considering unique local conditions, performing more detailed appraisals (external and internal), and using a larger number of neighborhood pairs as well as noise levels.

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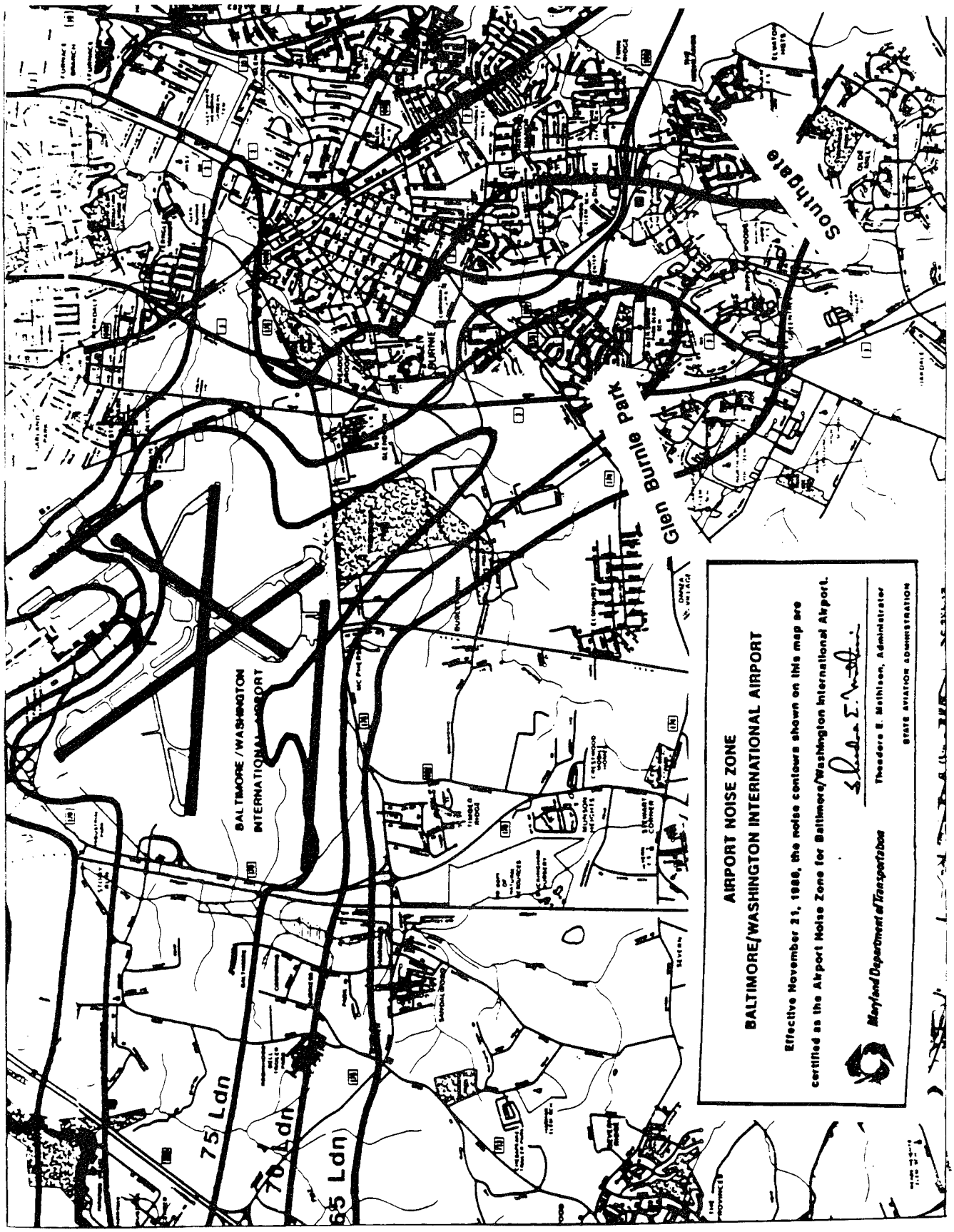
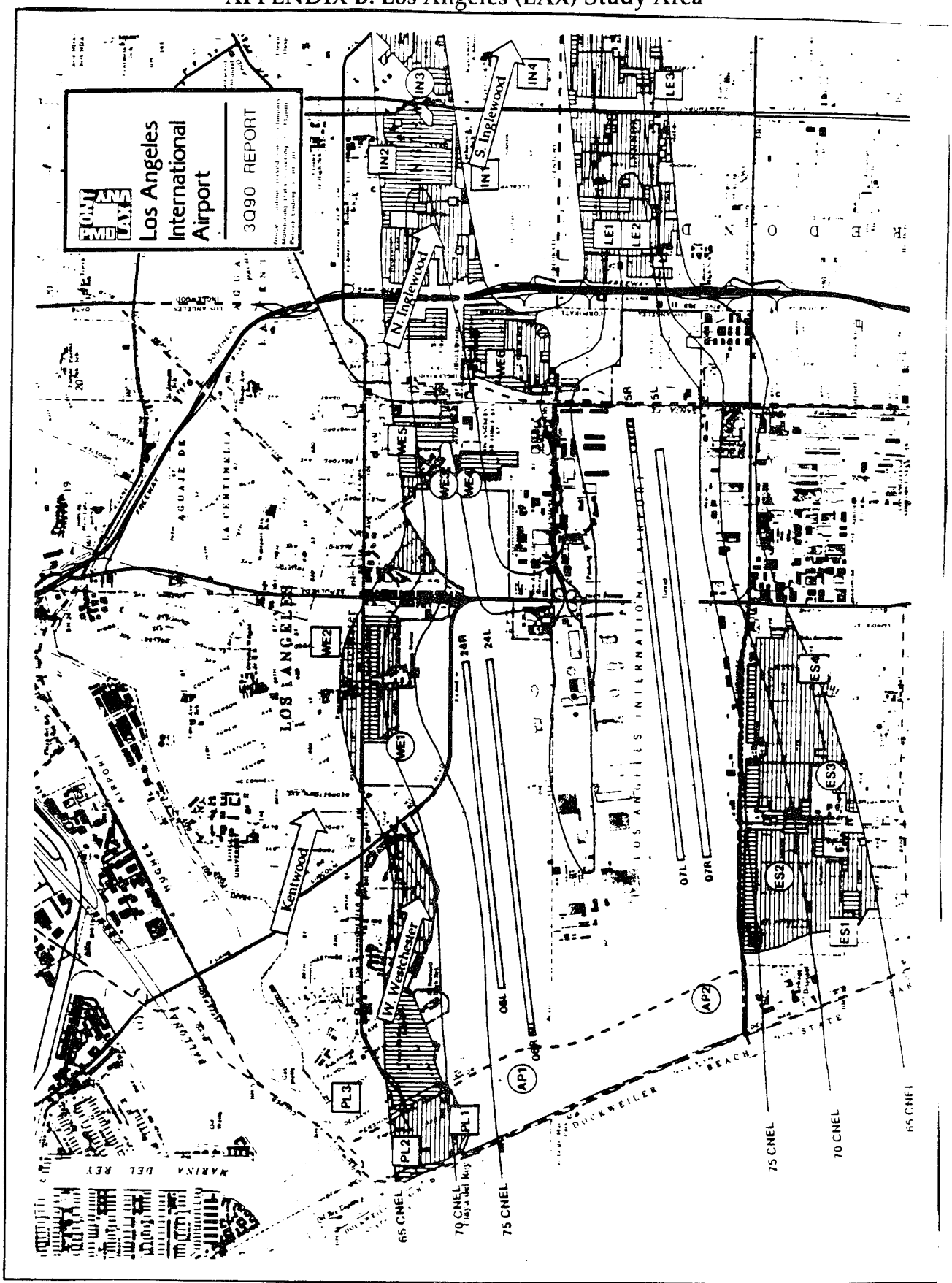
APPENDIX A: Baltimore/Washington International Airport (BWI) Study Area



APPENDIX B: Los Angeles (LAX) Study Area



APPENDIX C: New York Study Areas

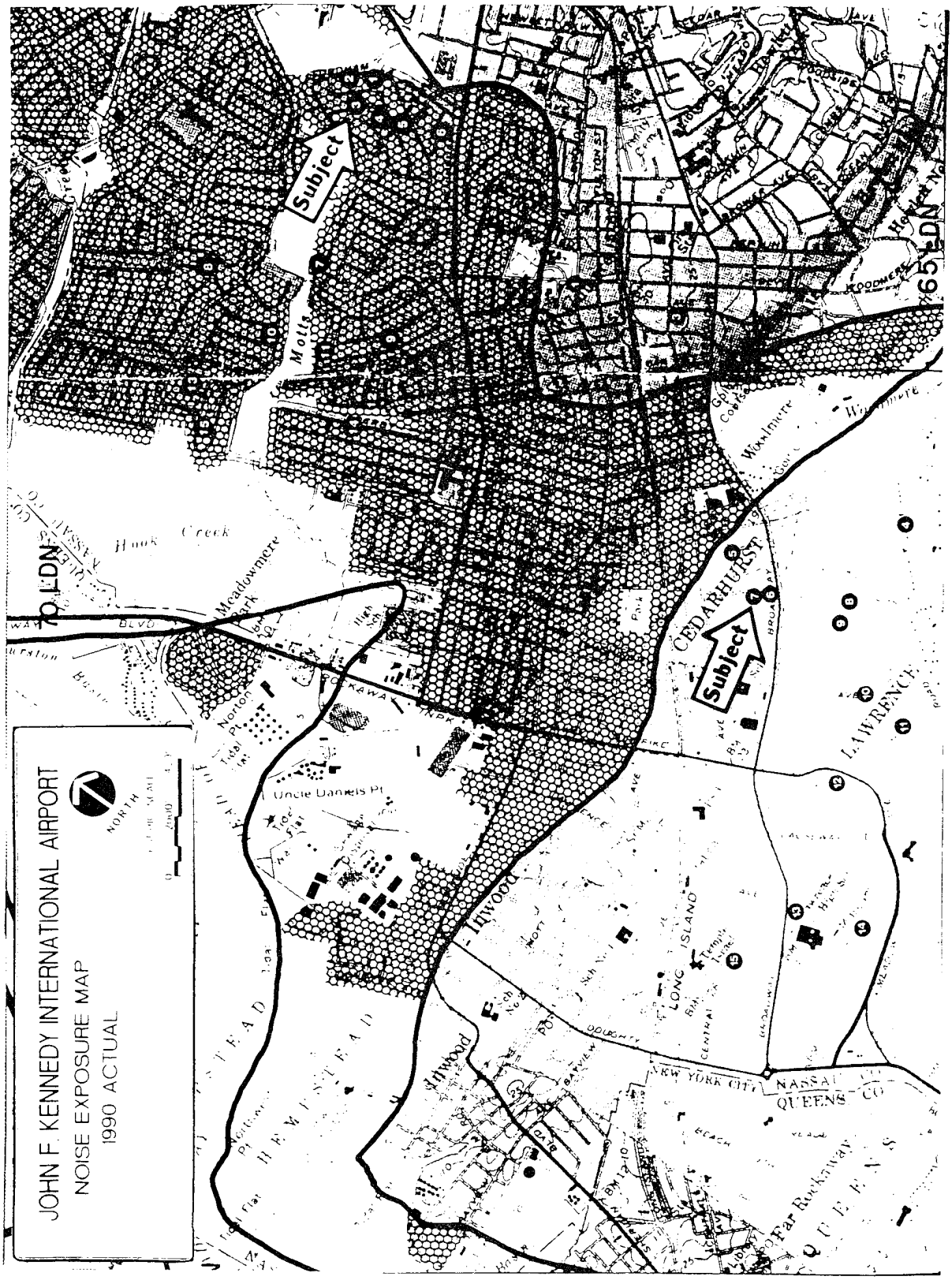


FIGURE C-1. JFK Study Area: High-Priced Neighborhoods

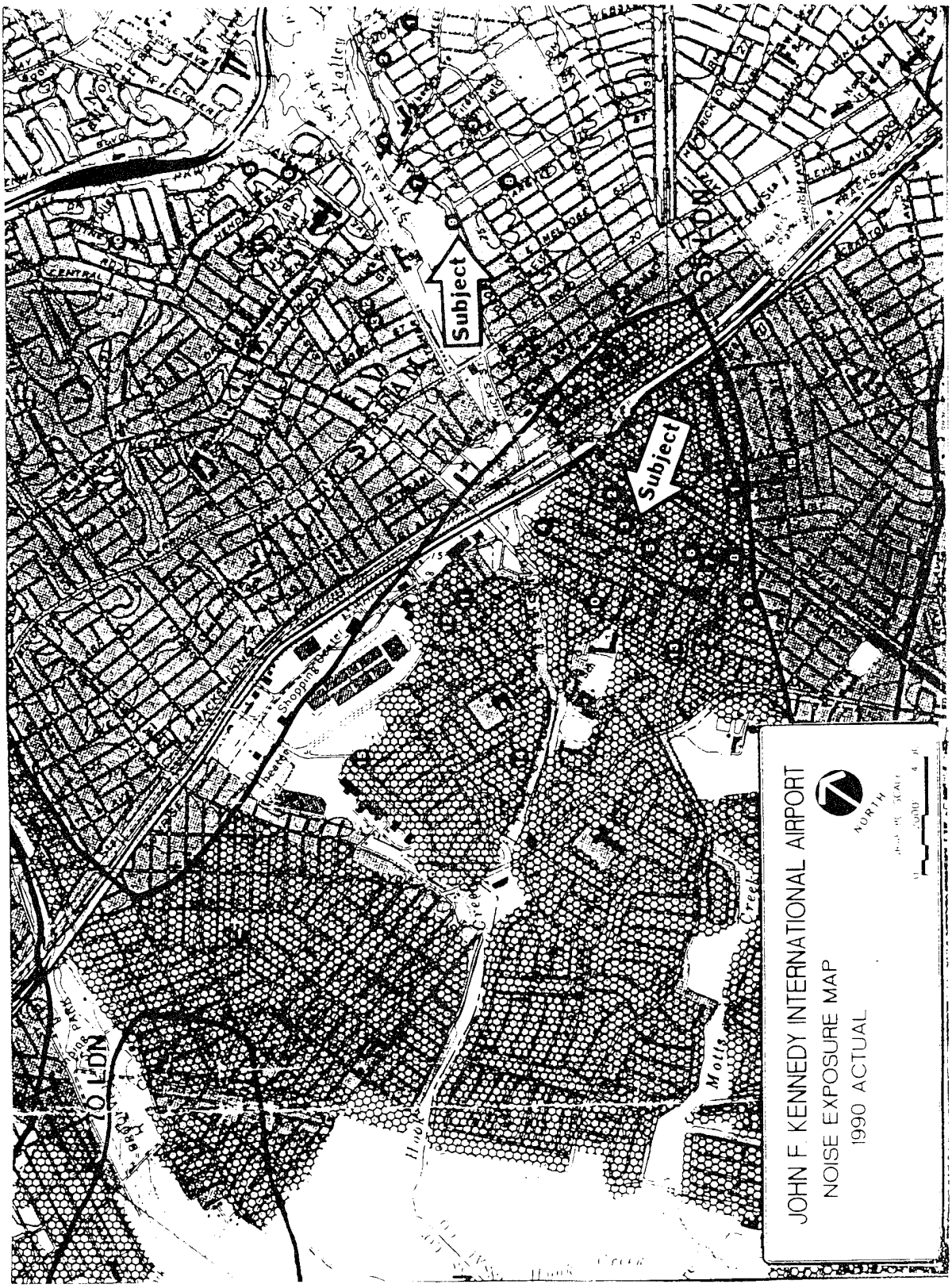


FIGURE C-2. JFK Study Area: Low-Priced Neighborhoods

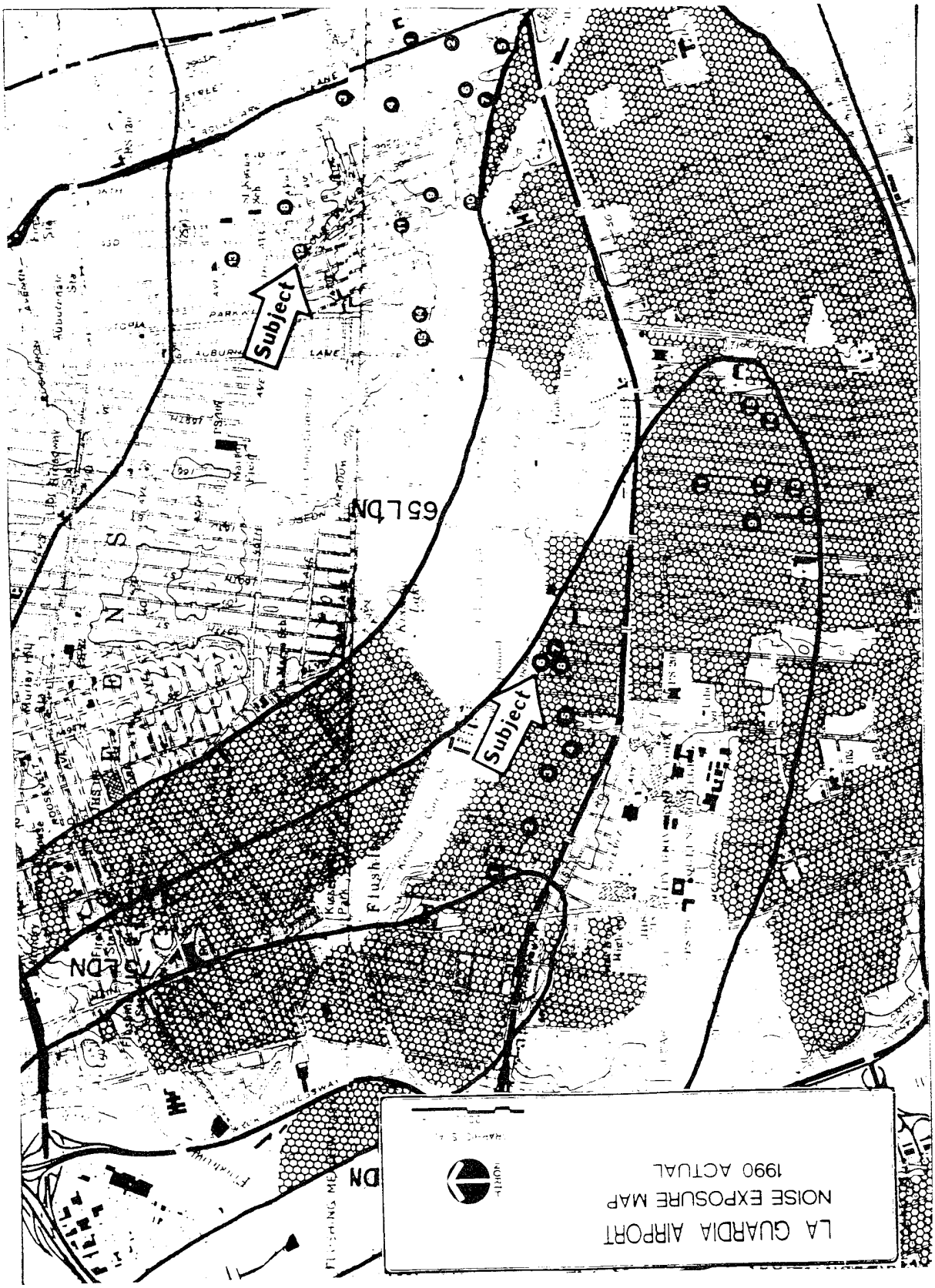


FIGURE C-3. LGA Study Area: Moderately-Priced Neighborhoods